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(12)(19)(CA) **Demande-Application**

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(54) **TRAITEMENT THERMIQUE POUR L'EXTERMINATION D'INSECTES**

(54) **HEAT TREATMENT FOR INSECT CONTROL**

(57) L'invention porte sur une méthode pour tuer les insectes en surface, consistant à traiter la surface avec une poudre de terre de diatomées, et à chauffer la surface traitée à une température d'au moins 35°C pendant assez longtemps pour tuer ces insectes.

(57) The invention relates to a method for killing insects on a surface, which comprises treating the surface with a diatomaceous earth powder, and heating the treated surface to a temperature of at least 35 °C for a period long enough to kill such insects.

ABSTRACT OF THE DISCLOSURE

The invention relates to a method for killing insects on a surface, which comprises treating the surface with a diatomaceous earth powder, and heating the treated surface to a temperature of at least 35° C for a period long enough to kill such insects.

HEAT TREATMENT FOR INSECT CONTROL

This invention relates to the control of insects by heat treatment.

Background of the Invention

It is known to control insect populations in grain and other cereal storage facilities by the application of heat. Thus, one method of insect control in such facilities is to heat the entire facility to a temperature which, if continued for sufficient time, kills the insect pests. Thus, heating the facility to, for example 50 degrees C for a period of 24 -48 hours, can be effective in some facilities. If done regularly, this leads to a reduction in the number of cereal feeding insects. However, heat treatment is not widely used as an insect control measure, because of the cost of heating large structures such as a flour mill or grain silo, the need for relatively frequent treatment (often more frequent than would be required with chemical pesticides) and concern about heat damage to buildings and facilities. Heat treatment would therefore be much more attractive economically if good results in killing insects could be obtained with a shorter period of heat application and a lower temperature.

Diatomaceous earth (the name is frequently shortened to "DE") is a geological deposit made up of the fossilized skeletons of diatoms, which are unicellular algae that live in seas, lakes, streams, and ponds. Diatoms get their unique shape by absorbing dissolved silica which is then converted into highly ordered shells. When these microscopic plants die, they settle to the bottom of lakes and seas and can form thick layers of nearly pure silicon dioxide. With time and pressure these layers are compressed into the deposits that are known as diatomaceous earth.

DE has been used to control stored-product pests for centuries. Before diatomaceous earth can be used as an insecticide, deposits must be dried and milled to separate individual diatoms which are between 1 to about 100 microns in

diameter. The fossilized diatoms are amorphous silicon dioxide which is nontoxic to mammals, and which is registered as a food additive in Canada, USA and in many other countries.

There are a number of diatomaceous earth insecticides on the market in Canada and United States, and some have been used as grain protectants. However, diatomaceous earth insecticides have had limited use, in part because of the widespread use of effective chemical insecticides such as methyl bromide, Malathion™, chlorpyrifos-methyl, phosphine and methyl bromide. In addition, some diatomaceous earth formulations have required very high concentrations, which were not acceptable to the grain industry, and some were not always effective.

A particularly desirable diatomaceous earth product is marketed under the name Protect-it™ by Hedley Technologies Inc. of Vancouver B.C. This product is a major proportion of diatomaceous earth, with a lesser proportion of precipitated silica or silica aerogel. It is sold commercially as a mixture of DE and 10% silica aerogel, and the manufacturer's recommendations are to apply it for insect control as a dry powder at 5 gm/m* . As discussed in Canadian Patent Application 2149164, filed May 11, 1995), it exhibits good flowability, less clumping and caking than normal diatomaceous earth, and excellent efficacity against insects.

Brief Description of the Invention

It has now been found that heat treatment can be made more effective than previously, and can be run for shorter periods and at lower temperatures than previously to give effective results, if a a diatomaceous earth coating is applied to the areas to be heat treated, prior to such treatment. The diatomaceous earth remains in place during the heat treatment, and acts synergistly with the heat treatment to kill insects.

Detailed Description of the Invention

Tests were carried out in a commercial oat mill in Peterborough, Ontario, Canada. The mill was equipped with heaters, and had a history of heat treating its premises four times a year to control insects. The standard heat treatment in that mill was by raising air temperature to 50 degrees C for a period of at least 24 hours.

The test was carried out by heating some areas within the mill buildings, and not other areas. The "unheated" areas were maintained at normal mill operating temperatures (floor temperatures of 16.9° to 23.7° C, depending on the area.) The heated areas were heated to an air temperature of at least 50°C. Floor temperatures were recorded while heating occurred. Typically, floor temperatures did not reach 50°C during the test.

The DE product used for the test was Protect-it™ Obtained from Hedley Technologies Inc. This was a mixture of 90% by weight DE and 10% by weight silica aerogel, and the particular batch used had less than 1% by weight of crystalline silica.

The species of insect used in the test was the confused flour beetle (*Tribolium confusum* Jacquelin du Val) because it cannot fly and is the main insect pest of food processing facilities. A flying pest could not be used in the commercial trial since the pests were placed in an open ring. *Tribolium* species are also good test insects as they are very tolerant to diatomaceous earth. Adult insects were placed in vials with 10 g. flour two days before the test, and were transported to the test site in such vials. They were sieved out of the flour and placed in the rings used for test purposes (which rings are described below) at the start of the test.

The test was designed to examine the effects of DE , heat, the combination of DE and heat and different application methods. To do this, four treatments were used:

1. Heat alone
2. Protect-It™ DE product alone
3. Heat with Protect-It™ DE product.
4. No heat or Protect-It™ DE product.

Three areas were selected for testing; oat mill (basement of building, heat-treated), hallway , not heat-treated) and equipment storage and cardboard compacting area (basement, not heat-treated).

Different test sites within the selected areas in the oat mill were treated with Protect-It using four methods of application to the floor:

1. As a dry powder with a power sprayer (Power Dust-er Model # 2250, B. and G. Equipment, PO Box 130, Applebutter Lane, Plumstead Ville, PA, USA).
2. As a dry powder using a hand duster (Dustin-Miser, R.J. Winmore Inc., PO. Box 1765, Sioux Falls, SD, 57101, USA).
3. As a 20% aqueous solution using a hand sprayer (Spray Doc, Gilmor Group, Mississauga, ON, L5S 1P7, fitted with a Teejet 11002vs spray nozzle. This gave a flat fan spray with 70 ml/10 s).
4. Distributed in measured amounts (1, 3, 7 g/m2) into rings.

Where equipment was used to apply the Protect-It™, it was operated by a technician trained in the use of the application equipment. Where the Protect-It™ was distributed in measured amounts into the rings, the participants evenly distributed it with a small brush.

Each treated area was in a separate part of the oat mill basement, with about 1 X 2 metres being treated. The test was carried out after a routine mill clean-up, as is normally carried out before the mill's routine heat treatment. Sections in each treated area were covered with plastic sheeting to prevent Protect-It™ from being applied to areas that were to serve as untreated sections.

To estimate the amount of Protect-It™ applied, plastic plates (10 cm x 10 cm, area = 0.01 m2) were preweighed with a Zip-Lock™ plastic bag and double backed tape, placed in areas before spraying, collected immediately after application, placed in plastic bags and reweighed. There were 3 plastic plates/treatment site.

To allow insects to be exposed to the heat treatment with space to move and yet prevent their escape into the food processing facility, they were placed in ABS plastic rings (15 cm diameter, 2 cm high, area of 0.018 m2). The rings were coated with liquid polytetrafluoroethylene (Teflon /Fluon™) to prevent insects from climbing out. The rings were set down on the floor and sealed along the outside edge using plasticine to prevent insects from escaping via cracks between the ring and the floor.

There were 3 rings for each treatment. Within a treatment, rings were about 5 cm apart.

Floor temperatures were taken in both treated and untreated sections (Fig. 1-3). Temperatures in the heated area were taken every minute and averaged and recorded every 10 minutes using a data logger. Air temperatures were also measured as usual by employees of the mill. These air temperatures were taken hourly at eye level in the four corners of each floor using a digital thermometer.

Results

Temperature and Relative Humidity - Air temperatures as measured by the data logger were above 50 C by two hours after the start of the test.. Air temperatures measured by mill employees in the four corners of the basement were all greater than 50 C by 7 hours after the test commenced.

Some fans on the unit heaters were turned off to prevent overheating. One set of rings, those set up beside the outside door, was in the airflow of one of the unit heaters. When this fan was turned off, the temperature in these rings and those on the closest window declined sharply. Floor temperatures in unheated areas were 16.9-17.1 C for the power dusted area and 20.4-23.7 C for the hand dusted and sprayed areas.

Relativity humidity started at 19% and declined to 5% in the heated basement. It remained constant in the unheated basement (power dusted) at 14% and ranged between 15 and 12% RH in the other unheated areas (sprayed, hand dusted and measured amounts). There was no attempt to calibrate the three different instruments used to measure relative humidity. Accuracy for these instruments is ±5% RH. Relative humidity is generally low in milling facilities, and this test was carried out during the winter weather.

Application Rates- Using an electrically-powered duster to apply the Protect It™ gave a fine, even application of approximately 1-2 g/m2 (Table 2). Using a hand-powered duster gave heavier application rates, approximately 4 g/m2, with uneven coverage. Water spray application left visible residues and gave 4-8 g/m2.

Insects - Three ways were used to measure the effectiveness of control of the combination method:

- temperature at time of death,
- duration of survival during treatment,
- survival at the end of treatment.

For the first two measures, the durations and temperatures for the first, median (50%)
and last insect to die are reported. All insects in the heated area that were treated with Protect-It™ died before the end of the treatment. There was some survival of insects in some of the heated areas that were not treated with Protect-It™ (See table 4 below.).

Results are summarized in the following tables:

Table 1 The rates of application of Protect-It™ using various methods of application.

Application Method	Area	Change in Weight[2] (g/m²) ±SEM		Significant Differences [1]
		DE-Treated	Untreated	
Power Duster	Heated	-1.9±1.2	-0.2±1.2	ns
	Unheated	1.4±0.3	0.1±0.3	*
Hand Duster	Heated	3.7±0.9	1.3±0.6	*
	Unheated	4.0±0.8	0.0±0.6	**
Hand Sprayer	Heated	8.6±1.8	0.0±0.4	**
	Unheated	3.8±0.3	-0.6±0.3	**

1. One-tailed t-test, ns= no significant difference, * = $p < 0.05$, ** = $p < 0.01$
2. Negative values are probably due to errors in measuring initial weight.

Table 2 The survival (%) of insects after heat treatment was complete.

Application Method	Area	Survival (%) ±SEM		Significant Differences [1]
		DE-Treated	Untreated	
Power Duster	Heated	0±0	9±4	*
	Unheated	100±0	100±0	ns
Hand Duster	Heated	0±0	0±0	ns
	Unheated	9±6	99±1	**
Hand Sprayer	Heated	0±0	0±0	ns
	Unheated	100±0	100±0	ns
Measured 3 g/m^2 Windows	Heated	0±0	3±2	ns
Measured 3g/m^2 Doors	Heated	0±0	17=15	ns
Measured 1 g/m^2 Floor	Heated	0±0	15±4	*
	Unheated	16±10	100±0	**
Measured 3 g/m^2 Floor	Heated	0±0	15±4	*
	Unheated	0±0	100±0	**
Measured 7 g/m^2 Floor	Heated	0±0	15±4	*
	Unheated	0±0	100±0	**

1. One-tailed t-test, ns= no significant difference, * = $p< 0.05$, **= $p<0.01$

Table 3 The duration of survival in heated and unheated areas, with and without Protect-It™.

Application Method	Area	Time of Death	Duration (h)±SEM		Significant Differences [1]
			DE-Treated	Untreated	
Power Duster	Heated	First	11±1	22±0	**
		Median	17±1	35±1	**
		Last	22±1	☹	-
	Unheated	First	☹	☹	-
		Median	☹	☹	-
		Last	☹	☹	-
Hand Duster	Heated	First	5±0	18±2	**
		Median	10±1	30±1	**
		Last	14±1	38±4	**
	Unheated	First	7±2	☹	-
		Median	18±2	☹	-
		Last	☹	☹	-
Hand Sprayer	Heated	First	11±3	15±2	ns
		Median	21±2	27±0.3	*
		Last	28±3	32±1	ns
	Unheated	First	☹	☹	-
		Median	☹	☹	-
		Last	☹	☹	-

1. One-tailed t-test, ns= no significant difference, * = $p < 0.05$, ** = $p < 0.01$
☹ Not achieved during heat treatment

Table 4 The duration of survival in heated and unheated areas, with and without Protect-It™.

Application Method	Area	Time of Death	Duration (h)±SEM		Significant Differences[1]
			DE-Treated	Untreated	
Measured Amounts 3 g/m² Windows	Heated	First	9±0.3	21±2	*
		Median	13±1	35±0	**
		Last	19±2	⊗	-
Measured Amounts 3 g/m² Doors	Heated	First	6±0	22±0	**
		Median	9±0.3	32±2	**
		Last	15±0	⊗	-
Measured Amounts 3 g/m² Door	Heated (in direct path of heated air)	First	3	8	-
		Median	5	8.5	-
		Last	6	10	-
Measured Amounts 1 g/m² Floor	Heated	First	9±0.3	20±3	*
		Median	14±0.2	36±2	**
		Last	21±1	⊗	-
	Unheated	First	12±2	⊗	-
		Median	29±3	⊗	-
		Last	⊗	⊗	-
Measured Amounts 3 g/m² Floor	Heated	First	6±1	20±3	*
		Median	9±0.4	36±2	**
		Last	15±1	⊗	-
	Unheated	First	11±1	⊗	-
		Median	16±0.2	⊗	-
		Last	27±2	⊗	-
Measured Amounts 7 g/m² Floor	Heated	First	5±0.3	20±3	*
		Median	9±1	36±2	**
		Last	13±2	⊗	
	Unheated	First	8±2	⊗	-
		Median	15±0.5	⊗	-
		Last	23±5	⊗	-

1. One-tailed t-test, ns= no significant difference, * = $p < 0.05$, ** = $p < 0.01$
⊗ Not achieved during heat treatment

Table 5 The temperature at different levels of mortality in heated areas, with and without Protect-It™.

Application Method	Area	Time of Death	Temperature (°C)±SEM		Significant Differences [1]
			DE-Treated	Untreated	
Power Duster	Heated	First	38.7±1.0	43.2±0.7	**
		Median	40.0±0.8	46.3±0.5	**
		Last	42.6±0.6	☹	-
Hand Sprayer	Heated	First	40.0±2.0	42.4±0.7	ns
		Median	43.9±1.4	45.5±1.7	ns
		Last	45.4±1.8	46.9±0.4	ns
Hand Duster	Heated	First	35.1±0.3	41.4±0.4	**
		Median	38.8±0.4	44.4±1.4	**
		Last	40.7±0.6	46.3±0.3	**
Measured Amounts 3 g/m² Windows	Heated	First	36.6±0.8	40.9±1.2	*
		Median	37.5±0.5	44.2±1.6	**
		Last	41.5±1.7	☹	-
Measured Amounts 3 g/m² Doors	Heated	First	35.8±2.9	42.7±0	*
		Medium	37.8±1.1	47.4±0.1	**
		Last	40.2±0.5	☹	-
Measured Amounts 3 g/m² Door	Heated (in direct path of heated air)	First	45.5	51.9	*
		Median	48.5	51.9	**
		Last	49.9	☹	-
Measured Amounts 1 g/m² Floor	Heated	First	37.5±0.4	41.4±0.9	*
		Median	39.6±0.3	46.4±0.4	**
		Last	41.9±0.5	☹	-
Measured Amounts 3 g/m² Floor	Heated	First	35.7±0.4	41.4±0.9	**
		Median	37.9±0.1	46.4±0.4	**
		Last	40.4±0.1	☹	-
Measured Amounts 7 g/m² Floor	Heated	First	35.2±0.1	41.4±0.9	**
		Median	37.2±0.3	46.4±0.4	**
		Last	39.0±0.8	☹	-

1. One-tailed t-test, ns= no significant difference, * = $p < 0.05$, ** = $p < 0.01$
☹ Not achieved during heat treatment

Conclusions about Effectiveness and Synergistic Effect of the Combination Treatment

1. In the heated area, dry application of Protect-It gave 100% mortality of the confused flour beetle adults after 13-22 hours and 41 C compared to untreated insects that required 32-38 hours and 46-47 C. In several sections of the floor, heat alone did not provide complete control, but heat and Protect-it™ did.

2. Using an electrically-powered duster to apply the Protect-It™ resulted in a fine, even application of approximately 1-2 g/m. This method places considerable dust in the air and requires the use of dust masks and eye goggles. Using a hand-powered duster gave heavier application rates of approximately 4 g/m, with uneven coverage. Water spray application left visible residues and caused little to no increase in insect mortality.

The foregoing has shown that the application of DE as a dry dust (but not as a water spray) enhances the effect of heat treatment of grain facilities to kill insects. Generally, such powder will be applied according to the manufacturer's recommendations as to coverage, although any amount, even amounts below the recommended coverage levels, will be of some use.

While it is preferred to use an enhanced DE such as Protect-it™, which has added silica aerogel, beneficial results are also available with DE products having no such additive.

It is understood that the foregoing describes specific embodiments of the invention, and that modifications will be apparent to those skilled in the art in the light of the foregoing description. Accordingly, the invention is not limited to such embodiments,

but includes all modifications and variations which fall within the spirt and scope of the appended claims.

THE CLAIMS:

1. A method for killing insects on a surface, which comprises treating the surface with a diatomaceous earth powder, and heating the treated surface to a temperature of at least 35° C for a period long enough to kill such insects.

2. A method as claimed in claim 1, in which the surface is located in a cereal treating facility.

3. A method as claimed in claim 2, in which the temperature is at least 40°C.

4. A method as claimed in claim 3, in which the period is at least 3 hours.

5. A method as claimed in claim 3, in which the period is at least 10 hours.

6. A method as claimed in claim 3 in which the period is at least 15 hours.

7. A method as claimed in any of claims 1-6, in which the diatomaceous earth powder is a dry free-flowing powder.

8. A method as claimed in any of claims 1-7 in which the diatomaceous earth is admixed with from 5% to 35% by weight of silica.

9. A method as claimed in any of claims 1-7 in which the diatomaceous earth is admixed with from 5% to 35% by weight of silica, in the form of silica gel or precipitated silica.

10. A method as claimed in any of claims 1-7 in which the diatomaceous earth is admixed with about 10% by weight of silica in the form of silica gel.

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DERWENT-WEEK: 199925

TITLE: Killing insects on surface by coating with diatomaceous earth powder and heating

INVENTOR: FIELDS, P

PATENT-ASSIGNEE: FIELDS P[FIELI]

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APPLICATION-DATA:

PUB-NO	APPL-DESCRIPTOR	APPL-NO	APPL-DATE
CA 2205673A	N/A	1997CA-2205673	May 16, 1997

INT-CL (IPC): A01M001/00

ABSTRACTED-PUB-NO: CA 2205673A

BASIC-ABSTRACT:

NOVELTY - Killing insects on a surface comprises coating the surface with diatomaceous earth powder and heating the surface to at least 35 deg. C for long enough to kill the insects

ACTIVITY - Insecticide.

MECHANISM OF ACTION - None given.

USE - The method is especially used to kill insects on surfaces in cereal factories.

Tests were carried out in a commercial oat mill against Tribolium confusum
(confused flour beetle) and four treatments were used:

(1) heat alone;

Protect-It (**diatomaceous earth**; RTM) alone;

(2) heat + Protect-It

(3) no treatment.

In the heated area, dry application of Protect-It gave 100 % mortality of the
beetles after 13-22 hours at 41 deg. C, while areas with no Protect-It applied
required 32-38 hours at 46-47 deg. C.

ADVANTAGE - The combination of the **diatomaceous earth** and heat is synergistic.

TITLE-TERMS: KILL INSECT SURFACE COATING **DIATOMACEOUS EARTH** POWDER HEAT

DERWENT-CLASS: C07 P14

CPI-CODES: C04-D02; C14-B04B; C14-S09;

CHEMICAL-CODES:
Chemical Indexing M2 *01*
Fragmentation Code
B114 B702 B720 B831 C108 C800 C802 C803 C804 C805
C807 M411 M431 M782 M904 M905 P002 P341 P862
Specfic Compounds
01694K 01694M

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Fragmentation Code
M431 M782 M905 P002 P341 P862
Specfic Compounds
A00GTK A00GTM

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